

POWERTEC

DIGIMAX IV

BINARY COMMUNICATIONS PROTOCOL

SYSTEM COMMAND
AND
CONTROL LANGUAGE

APPLICATION MANUAL

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POWERTEC Industrial Motors

Mailing Address: P.O. Box 2650 * Rock Hill, South Carolina USA 29732 * PHONE: 803-328-1888
Shipping Address: 2606 Eden Terrace * Rock Hill, South Carolina USA 29730 * FAX: 803-328-1870

DIGIMAX IV

BINARY COMMUNICATIONS PROTOCOL

1.0 GENERAL INFORMATION

The DIGIMAX IV BINARY Communications protocol is a very fast, simple, and efficient means of communication between a host and DIGIMAX IV units. The speed and power of the BINARY protocol is most noticeable when there are a large number of units operating in a system.

The BINARY protocol has provisions for error checking in the RS-422 communications link.

The DIGIMAX IV must be in the REMOTE mode before the unit may accept parameter changes via the communications link. However, information may be requested from any DIGIMAX IV unit by the host through the link whether or not the DIGIMAX IV is in REMOTE mode.

Besides querying and modifying parameters, there is an analog input which may be read through an 8-bit D/A converter. There are also six open collector outputs to operate external relays for control functions, and control inputs can be read through the RS-422 link to determine system status.

The host may down-load the entire parameter list in case it has been changed since the last change or down-load.

Each DIGIMAX IV must have a unique I.D. number (parameter #17). The default is 1. This parameter may not be changed by the RS-422 link.

2.0 CONVENTIONS

1. The communications link conforms to the industry standard RS-422 specification, 4-wire plus ground.
2. Baud rate is programmable (parameter #18). All network units, including the host, must be set for the same baud rate.
3. Default communications specifications are 9600 baud, 8 bit, no parity, 1 stop bit.
4. GENERAL DEFINITIONS:

TOKEN	HEX	DEFINITION
[STX]	02h	Start of data
[ETX]	03h	End of data
[ACK]	06h	Acknowledge
[NAK]	15h	Negative acknowledge
[DLE]	10h	Data link escape
[CMD]	xxh	Command to be executed
[UID]	xxh	Unit being addressed
[CSM]	xxh	Checksum, 2's complement

[STX] and [ETX] must be preceded by [DLE] or they will not be interpreted as commands.

If the number 10h occurs in data, it must be sent twice because 10h is [DLE]. Only one is counted in [CSM].

The checksum is the 2's complement of the sum of the data between the [STX] and [ETX] characters. No Error message or response of any kind will be made if [CSM] is incorrect.

EXAMPLE: suppose the following speed command message is to be sent:

[DLE][STX][UID][CMD][00][00][02][10][DLE][ETX][CSM]

which is a speed command of 528 (decimal). To unit 4 it would be sent out as:

[10][02][04][82][00][00][02][10][10][10][03][68].

The sum of the data between [STX] and [ETX] is $04+82+00+00+02+10 = 98$; 2's complement = 67

The last data digit is 10h, so an extra [DLE] is sent to confirm that the 10h is a number.

3.0 HEXADECIMAL NOTATION

All communications in the Binary Protocol are in hexadecimal format, which is standard for computers.

Decimal numbers (0 - 9) use a base 10. A small "d" may be used after the number to show it is in decimal notation, but this is almost always omitted.

Binary numbers (0 - 1) use a base 2. A small "b" is used after the number to show it is binary.

Hexadecimal numbers (0 - F) use a base of 16. A small "h" is used after the number to show it is hexadecimal.

Hexadecimal digits 0 to F correspond to the decimal numbers 0 to 15:

0d = 0h	4d = 4h	8d = 8h	12d = Ch
1d = 1h	5d = 5h	9d = 9h	13d = Dh
2d = 2h	6d = 6h	10d = Ah	14d = Eh
3d = 3h	7d = 7h	11d = Bh	15d = Fh

The number 16 decimal is 10 in hexadecimal notation, and 17d = 11h. As is the case with decimal numbers, each digit carries a 1 to the left when it reaches its maximum value.

The hexadecimal number FF is equal to the decimal number 255. In computer useage, this is called a byte.

Characters are 1 byte (0-FF). These values represent decimal numbers from 0 to 255.

Integers are 2 bytes (0-FF FF). This represents decimal numbers from 0 to 65,535.

Long integers are 4 bytes (0-FF FF FF FF). This represents decimal numbers from 0 to 4,294,967,295.

To convert an integer from decimal to hexadecimal (a good calculator is helpful), start at the right hand position:

If the number is less than 16, write down the number from the table above in the last position.

If the number is greater than 16, divide it by 16, moving one position to the left. The resulting number should be an integer (the numbers before the decimal point) and a decimal number (the numbers after the decimal point)(the decimal value may be 0). If the integer portion is greater than 16, continue to divide the entire number by 16, moving one position to the left in the hexadecimal number, until the integer portion is less than 16.

Once the integer portion is less than 16, convert it to hexadecimal from the table above and write down the hexadecimal number. Then multiply the decimal portion by 16. This will result in a new number with an integer portion and a decimal part. Convert the integer part to hexadecimal and write this number to the right of the first number. Continue this process until the decimal portion comes out to zero (if you started with a decimal number with no decimal part, it will come out to zero).

EXAMPLE: Convert 2000 to hexadecimal.

2000 is greater than 16	—
$2000/16 = 125$	—
$125/16 = 7.8125$	7 —
$.8125 \times 16 = 13$	7 D _
Fill the last position with a 0	7 D 0

EXAMPLE: Convert 8751 to hexadecimal.

8751 is greater than 16	—
$8751/16 = 546.9375$	—
$546.9375/16 = 34.18359375$	—

4.0 DIGIMAX IV PARAMETER LIST

Following is the list of DIGIMAX IV parameters:

Number	Description of Parameter	Data Type	Min...Max	Remarks	
1	Maximum Motor Speed	UINT	0 ... FFFFh	Max value = 65535d	
2	Maximum Display Value	ULNG	0 ... 0001869Fh	Max Value = 99999d	
3	Decimal Location	UCHR	0 ... 04h	Number of decimal places	
4	Base Ratio	ULNG	0 ... 0001869Fh	Max Value = 99999d	
5	Encoder PPR	UINT	0 ... 1388h	Max Value = 5000d	
6	Acceleration Ramp Rate	UINT	0 ... 270F	1/10th's of seconds (999.9)	
7	Deceleration Ramp Rate	UINT	0 ... 270F	1/10th's of seconds (999.9)	
8	Master/Slave/Inverse Mode	UCHR	0 ... 02h	No change during RUN	
9	Preset Speed	ULNG	0 ... 0001869Fh	Max Value = 99999	
10	Jump Up Delta	ULNG	0 ... 0001869Fh	Absolute number	
11	Jump Down Delta	ULNG	0 ... 0001869Fh	Absolute number	
12	Up to Speed Tolerance	UCHR	0 ... FFh	Absolute number	
13	MOP/Jump Mode	UCHR	0 ... 01h		
14	Freeze/Float Mode	UCHR	0 ... 01h		
15	Display Sample Rate	UCHR	1 ... FFh	Max Value = 255	
16	Allow Setup During Run	UCHR	0 ... 01h		
*	17	Unit ID Number	UCHR	1 ... FFh	See Note below
**	18	Baud Rate	UCHR	3 ... 60h	See Note below
***	19	Local/Remote/Keylock	UCHR	0 ... 02h	See Note below
20	Speed Setpoint	ULNG	0 ... 0001869Fh		
21	Operator Password	ULNG	0 ... 0001869Fh	Max Value = 99999	
22	A to D Low Engr Units	UINT	0 ... 03E7h		
23	A to D High Engr Units	UINT	0 ... 03E7h		
24	A to D Display Mode	UCHR	0 ... 01h		
25	A to D Sample Rate	UCHR	1 ... FFh		
26	A to D Trim Enable	UCHR	0 ... 01h		
27	Communications Protocol	UCHR	0 ... 03h		
28	D to A Source	UCHR	0 ... 03h		
29	D to A Low Engineering Units	ULNG	0 ... 0001869Fh		
30	D to A High Engineering Units	ULNG	0 ... 0001869Fh		
31	Maximum Ratio	ULNG	0 ... 0001387Fh		
32	Preset Input Mode	UCHR	0 ... 02h		
33	Reverse Input Mode	UCHR	0 ... 02h		
34	Up Input Mode	UCHR	0 ... 01h		
35	Down Input Mode	UCHR	0 ... 01h		
36	Installed Option Enable	UCHR	0 ... 02h		
37	Command Ratio Setpoint	ULNG	0 ... 0001869Fh		
38	Minimum Ratio	ULNG	0 ... 0001869Fh		
39	Debounce Value	UCHR	0 ... FFh		
40	At Speed Source	UCHR	0 ... 1h		

* Unit ID cannot be changed by protocol

** Baud Rate value must be 03h (for 300), 06h (for 600), 0Ch (for 1200), 18h (for 2400), 30h (for 4800) or 60h (for 9600).

*** Protocol cannot change from LOCAL mode to REMOTE or KEYLOCK modes

Command: READ SPEED AND STATUS

This command from the host tells the DIGIMAX IV to respond with a message containing its current values of:

1. commanded speed
2. actual speed
3. auxiliary analog input
4. auxiliary outputs status
5. control inputs status

Command Message: [DLE][STX][UID][CMD][DLE][ETX][CSM]

Valid values of [UID] are: 0x01 through 0xFF (1 to 255).
The command number [CMD] is: 0x81.

Response: The DIGIMAX IV addressed will respond:

[DLE][STX][UID][ACK][CS4][CS3][CS2][CS1][AS4][AS3][AS2][AS1][ATD][ST2][ST1][DLE][ETX][CSM]

The unit addressed responds with its ID number [UID] and an acknowledgement [ACK] and proceeds to send data as follows:

[CS4][CS3][CS2][CS1]	Commanded speed, unsigned long integer, MSB first, range = 0-1869Fh
[AS4][AS3][AS2][AS1]	Actual speed, unsigned long integer, MSB first, range = 0-1869Fh
[ATD]	Analog input value at TB2 terminals 15 and 17, one byte, range = 0-FFh
[ST2]	Auxiliary outputs status, one byte of eight bits, range: 0 = OFF, 1 = ON
	bit 7 = At speed status
	bit 6 = Remote/local status
	bit 5 = Auxiliary output #6
	bit 4 = Auxiliary output #5
	bit 3 = Auxiliary output #4
	bit 2 = Auxiliary output #3
	bit 1 = Auxiliary output #2
	bit 0 = Auxiliary output #1
[ST1]	Control inputs status, one byte of eight bits, range: 0 = OFF, 1 = ON
	bit 7 = Not used
	bit 6 = Master/Slave status
	bit 5 = Down input
	bit 4 = Up input
	bit 3 = Reverse input
	bit 2 = Preset input
	bit 1 = EStop input
	bit 0 = Run input

Errors: If an entry error is made in the CMD value, the DIGIMAX IV will respond:

0x89 = Illegal Command

Command: SET SPEED

This command from the host tells the DIGIMAX IV to enter a new speed in memory, but does not instruct the unit to act upon the new speed. This command must be followed by an execute command for the new speed to take effect.

Command Message: [DLE][STX][UID][CMD][CS4][CS3][CS2][CS1][DLE][ETX][CSM]

Valid values of UID are: 0x01 through 0xFF (1 to 255).

The command number [CMD] is: 0x82.

The unit addressed is sent data as follows:

[CS4][CS3][CS2][CS1] Commanded speed, unsigned long integer, MSB first, range = 0-0001869Fh

Response: If there are no errors, the DIGIMAX IV addressed will respond:

[DLE][STX][UID][ACK][DLE][ETX][CSM]

The unit addressed responds with its ID number [UID] and an acknowledgement [ACK].

Errors: If there is an error, the DIGIMAX IV addressed will respond:

[DLE][STX][UID][NAK][ERR][DLE][ETX][CSM]

The unit addressed responds with its ID number [UID] and an acknowledgement [NAK] and an error number:

[ERR]

Reported error

0x80 = Unit not in REMOTE mode

0x81 = Illegal speed value

0x89 = Illegal Command

Command: EXECUTE SPEED

This command from the host tells the DIGIMAX IV to execute a new speed previously entered in memory.

Command Message: [DLE][STX][UID][CMD][DLE][ETX][CSM]

Valid values of UID are: 0x00 through 0xFF (0 to 255).

A "0" is a global command to all units on the network.

The command number [CMD] is: 0x83.

Response: If there are no errors and the [UID] is not "0", the DIGIMAX IV addressed will respond:

[DLE][STX][UID][ACK][DLE][ETX][CSM]

The unit addressed responds with its ID number [UID] and an acknowledgement [ACK].

There is no response to a global command ([UID] = 0).

Errors: If there is an error when [UID] is not "0", the DIGIMAX IV addressed will respond:

[DLE][STX][UID][NAK][ERR][DLE][ETX][CSM]

The unit addressed responds with its ID number [UID] and an acknowledgement [NAK] and an error number:

[ERR]

Reported error

0x80 = Unit not in REMOTE mode

0x89 = Illegal Command

.136474609	16 = 2.18359375	2 2 _ _
.18359375 x 16	= 2.9375	2 2 2 _
.9375 x 16	= 15 (F)	2 2 2 F

Command: SET AND EXECUTE SPEED

This command from the host tells the DIGIMAX IV to enter a new speed in memory AND to implement the new speed immediately. No additional command is necessary.

Command Message: [DLE][STX][UID][CMD][CS4][CS3][CS2][CS1][DLE][ETX][CSM]

Valid values of UID are: Ox01 through OxFF (1 to 255).

The command number [CMD] is: Ox84.

The unit addressed is sent data as follows:

[CS4][CS3][CS2][CS1] Commanded speed, unsigned long integer, MSB first, range = 0-1869Fh

Response: If there are no errors, the DIGIMAX IV addressed will respond:

[DLE][STX][UID][ACK][DLE][ETX][CSM]

The unit addressed responds with its ID number [UID] and an acknowledgement [ACK].

Errors: If there is an error, the DIGIMAX IV addressed will respond:

[DLE][STX][UID][NAK][ERR][DLE][ETX][CSM]

The unit addressed responds with its ID number [UID] and an acknowledgement [NAK] and an error number:

[ERR]

Reported error

Ox80 = Unit not in REMOTE mode

Ox81 = Illegal speed value

Ox89 = Illegal Command

Command: READ PARAMETER

This command from the host tells the DIGIMAX IV to return to the host the value of a parameter.

Command Message: [DLE][STX][UID][CMD][PRM][DLE][ETX][CSM]

Valid values of UID are: 0x01 through 0xFF (1 to 255).

The command number [CMD] is: 0x85.

The unit addressed is sent a parameter request as follows:

[PRM] Requested parameter, range = 1 - 20

[PRM] = 1 through 20, send the requested parameter value.

NOTE: If parameter # 10 is called in [PRM], an extra [DLE] must be sent to confirm [PRM] is a number.

Response: If there are no errors, the DIGIMAX IV addressed will respond:

[DLE][STX][UID][ACK][DAT][DLE][ETX][CSM]

The unit addressed responds with its ID number [UID] and an acknowledgement [ACK], and then sends the requested data.

See the DIGIMAX IV parameter list in Section 4.0, which lists the data format of all of the parameters.

[DAT] parameter requested, unsigned long integer, range = 0 - 0001869Fh

UCHR = unsigned character (0-FF), UINT = unsigned integer (0-FFFF), ULNG = unsigned long (0-FFFFFFFF)

Errors: If there is an error, the DIGIMAX IV addressed will respond:

[DLE][STX][UID][NAK][ERR][DLE][ETX][CSM]

The unit addressed responds with its ID number [UID] and an acknowledgement [NAK] and an error number:

[ERR] Reported error

0x82 = Illegal parameter number

0x89 = Illegal Command

Command: WRITE PARAMETER

This command from the host tells the DIGIMAX IV to write the value of the selected parameter.

Command Message: [DLE][STX][UID][CMD][PRM][VL4][VL3][VL2][VL1][DLE][ETX][CSM]

Valid values of UID are: 0x01 through 0xFF (1 to 255).

The command number [CMD] is: 0x86.

The unit addressed is sent a parameter value as follows:

[PRM] Parameter value to write, range = 1 - 20

NOTE: If parameter # 10 is called in [PRM], an extra [DLE] must be sent to confirm [PRM] is a number.

See the parameter listing in Section 4.0 for formats and ranges of parameters..

[VL4][VL3][VL2][VL1]Parameter value, unsigned long integer, MSB first, range = 0 - 0001869Fh

Response: If there are no errors, the DIGIMAX IV addressed will respond:

[DLE][STX][UID][DAT][DLE][ETX][CSM]

The unit addressed responds with its ID number [UID] and an acknowledgement [ACK], and then sends data as follows:

Errors: If there is an error, the DIGIMAX IV addressed will respond:

[DLE][STX][UID][NAK][ERR][DLE][ETX][CSM]

The unit addressed responds with its ID number [UID] and an acknowledgement [NAK] and an error number:

[ERR]

Reported error

0x80 = Unit not in REMOTE mode

0x82 = Illegal parameter number

0x83 = Illegal parameter value

0x89 = Illegal Command

Command: WRITE AUXILIARY OUTPUT

This command from the host tells the DIGIMAX IV to return to toggle the state of the auxiliary output if it is not in the state commanded.

Command Message: [DLE][STX][UID][CMD][AUX][VAL][DLE][ETX][CSM]

Valid values of UID are: Ox01 through OxFF (1 to 255).

The command number [CMD] is: Ox87.

The unit addressed is sent a command as follows:

[AUX]	Auxiliary output to toggle, range = 1 - 6
[VAL]	Toggle command, range : 0 = OFF , 1 = ON

Output will not change state if it is in the sate commanded.

Response: If there are no errors, the DIGIMAX IV addressed will respond:

[DLE][STX][UID][ACK][DLE][ETX][CSM]

The unit addressed responds with its ID number [UID] and an acknowledgement [ACK], and then sends data as follows:

Errors: If there is an error, the DIGIMAX IV addressed will respond:

[DLE][STX][UID][NAK][ERR][DLE][ETX][CSM]

The unit addressed responds with its ID number [UID] and an acknowledgement [NAK] and an error number: [ERR]

Reported error

Ox80 = Unit not in REMOTE mode

Ox84 = Illegal auxiliary number

Ox85 = Illegal auxiliary value

Ox89 = Illegal Command

Command: WRITE ANALOG OUTPUT

This command from the host tells the DIGIMAX IV to output a specific voltage on the analog output.

PARAMETER 28 MUST BE SET TO "2" (RS422 source) BEFORE WRITING TO THE ANALOG OUTPUT WITH THIS COMMAND!

Command Message: [DLE][STX][UID][CMD][VL4][VL3][VL2][VL1][DLE][ETX][CSM]

Valid values of UID are: 0x01 through 0xFF (1 to 255).

The command number [CMD] is: 0x88.

The unit addressed is sent a command as follows:

[VL4][VL3][VL2][VL1] Commanded Value, unsigned long integer, MSB first, range = 0-0001869Fh

Response: If there are no errors, the DIGIMAX IV addressed will respond:

[DLE][STX][UID][ACK][DLE][ETX][CSM]

The unit addressed responds with its ID number [UID] and an acknowledgement [ACK], and then sends data as follows:

Errors: If there is an error, the DIGIMAX IV addressed will respond:

[DLE][STX][UID][NAK][ERR][DLE][ETX][CSM]

The unit addressed responds with its ID number [UID] and an acknowledgement [NAK] and an error number: [ERR]

Reported error

0x80 = Unit not in REMOTE mode

0x87 = Unit not set for comm control of output

0x88 = Illegal output value

0x89 = Illegal Command

EXAMPLE:

If, on unit #27, parameter #28 (D/A source) is set to 2 (RS-422), parameter #29 (LOW EGU = 0VDC) is set to 0, and parameter #30 (HIGH EGU = 10 VDC) is set to 2000, then the number 07D0h (2000 decimal) will put out 10VDC from the analog output:

The message [DLE][STX][1B][88][00][00][07][D0][DLE][ETX][CSM] commands 10 VDC output.

The message [DLE][STX][1B][88][00][00][01][5E][DLE][ETX][CSM] commands 3.5 VDC output.

If, on the same unit, parameter #29 (LOW EGU = 0VDC) is changed to 100, then:

The message [DLE][STX][1B][88][00][00][01][5E][DLE][ETX][CSM] commands 1.316 VDC output.
because $(350-100)/(2000-100) * 10 \text{ VDC} = 1.316 \text{ VDC}$

NOTES:

1. If parameter number 28 is set to 0, 1, or 3, an error message will be generated.
2. The value entered by this command must be equal to or greater than parameter number 29 and less than or equal to parameter number 30. A number less than parameter 29 or more than parameter 30 will generate an error signal.

